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# Development of a Simplified Tool for Assessing Climate Change Impact in Dairy Cattle Farms



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# BACKGROUND



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From studies carried out in the last 10 years, on a very large number of dairy cattle farms in Northern Italy, mostly intensive, it has been estimated that the production of a kilogram of fat and protein corrected milk results in emissions ranging from a minimum of 1.3 to a maximum of 2.7 kg of CO<sub>2</sub> eq, with an average value of about 2.0 kg of CO<sub>2</sub> eq /kg milk

# ENVIRONMENTAL IMPACT ASSESSMENT ...

Life Cycle Assessment-LCA

SHARED EVALUATING METHOD

TIME CONSUMING METHOD



01

Allows to assess the overall impact of each phase of the production process, considering the entire life cycle of the product.

02

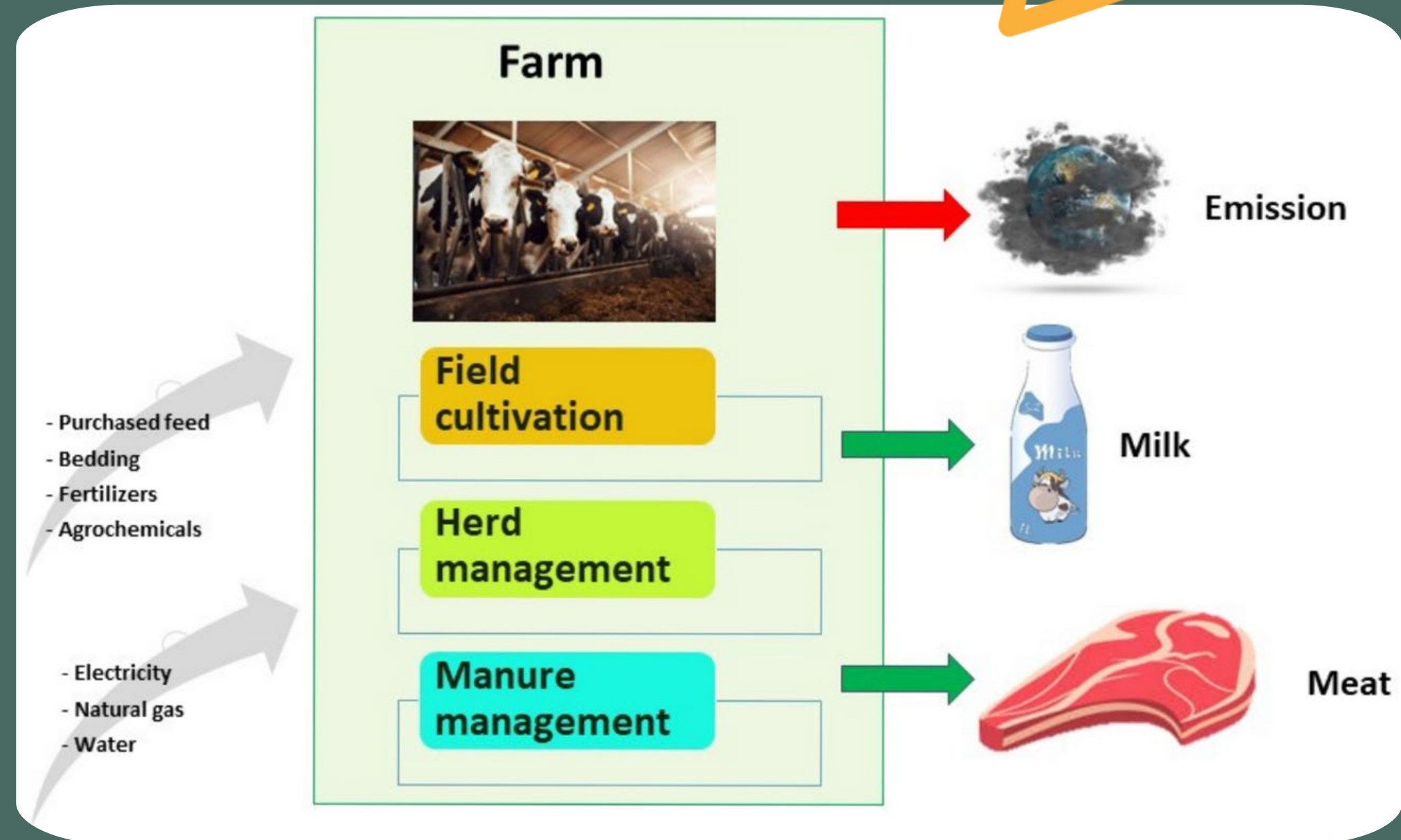
Allows the identification of critical points and emission-related issues, using a common method evaluating

03

All the inputs necessary for production are considered, e.g. raw materials and energy used in processes.

04

All that is produced by the system (all the outputs) are calculated, namely milk and meat, but also emissions.





# AIM

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To develop a simplified system for estimation of the carbon footprint of cow milk, which can be used by farmers:

- as a self-assessment system
- to simulate what would happen if some indicators varied

# SIMPLIFIED SYSTEM FOR THE EVALUATION OF CLIMATE CHANGE OF MILK PRODUCTION ...

**ANAFIBIJ**

- Data of animal management
- Data of fertility
- Genetic Indices

**DISAA**

- Calculation for estimating environmental impact
- Experience in applying Life Cycle Assessment method



**DiSAA**  
DIPARTIMENTO  
di SCIENZE  
AGRARIE e  
AMBIENTALI

# FARM SAMPLE

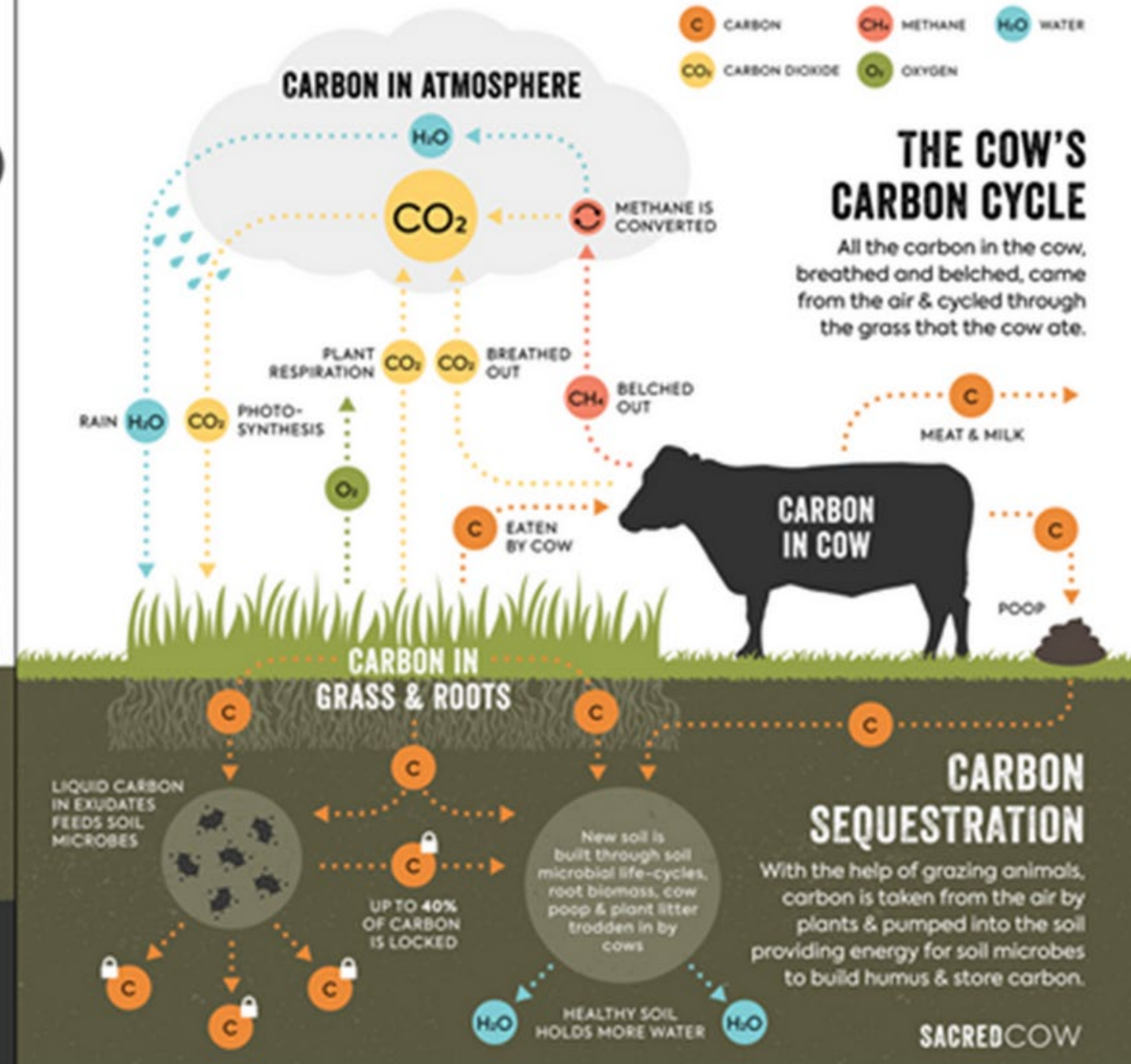
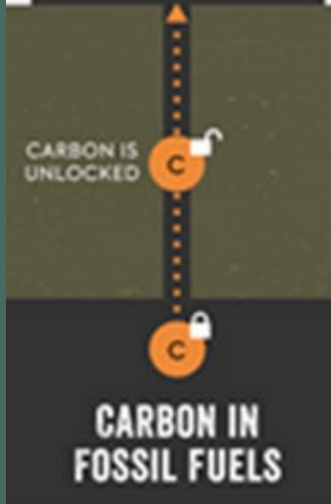
- 54 farms (Holstein Friesian cows) located in Northern Italy, in plain and hill areas
- Complete LCA analysis
- Performance data: production, management and fertility data (i.e. pregnant cows at 120 d, and milk sold per Livestock Unit, LU), and genetic indices (i.e. Health and Economic Index - IES, predicted Methane Emission Index - pCH4)



# CATTLE CARBON CYCLING VS. FOSSIL FUELS

@SUSTAINABLEDISH | SACREDCOW.INFO

## FOSSIL FUELS



# CLIMATE CHANGE

## Carbon from enteric fermentations

The biogenic carbon is part of a short cycle that is considered in equilibrium with carbon fixed and stored by plants in the form of carbohydrates, and ingested by animals

## Carbon from fossil fuels

It represents new carbon transfers, from long-term geological reserves to the atmosphere, meaning a net addition of carbon in the atmosphere

# STATISTICAL ANALYSIS



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- **SAS and R studio Software**
- **Descriptive statistics:** The complete data set was analysed for descriptive statistic (Proc MEANS).
- **MULTIVARIATE ANALYSIS:** A Principal Component Analysis (PCA, Proc PRINCOMP) was performed to find a multidimensional relation between variables.
- **PREVISIONAL EQUATION:** linear model with stepwise selection.  
Starting from a collinearity test, variables with high VIF (Variance Inflation Factor) were excluded from the dataset.  
Stepwise procedure (Ordinary Least Squares, OLS) to select the best parameters for CC\_es. Validation of the equation was performed by randomly selecting 15 farms from the database 1,000 times to test the equation, and the average correlation coefficient between CC\_es and CC was calculated.

ACKNOWLEDGMENTS: Dr. Alberto Cesarani and Dr. Arianna Bionda for statistics advises



# RESULTS-DESCRIPTIVE STATISTICS



Table 1. Summary of descriptive statistic

*Table 1. Summary of descriptive statistic.*

Variable	Unit	Mean	Std	Min	Max
Lactating cows	n	232	186	56.0	817
FPCM <sup>1</sup> per lactation	kg	9591	1357	6754	13284
Fat	%	3.83	0.23	3.28	4.23
Protein	%	3.40	0.12	3.02	3.70
Soybean meal in the ration	%	10.7	5.28	0	22.5
IES index <sup>2</sup>		161	159	-93.6	733
CH4 index <sup>3</sup>		100	1.42	97.1	105
Age at first calving	month	26.9	2.47	23.0	34.7
Pregnant cows at 120 d	%	58.3	9.25	37.0	73.0
Milk sold per LU <sup>4</sup>	kg	6239	827	4494	8093

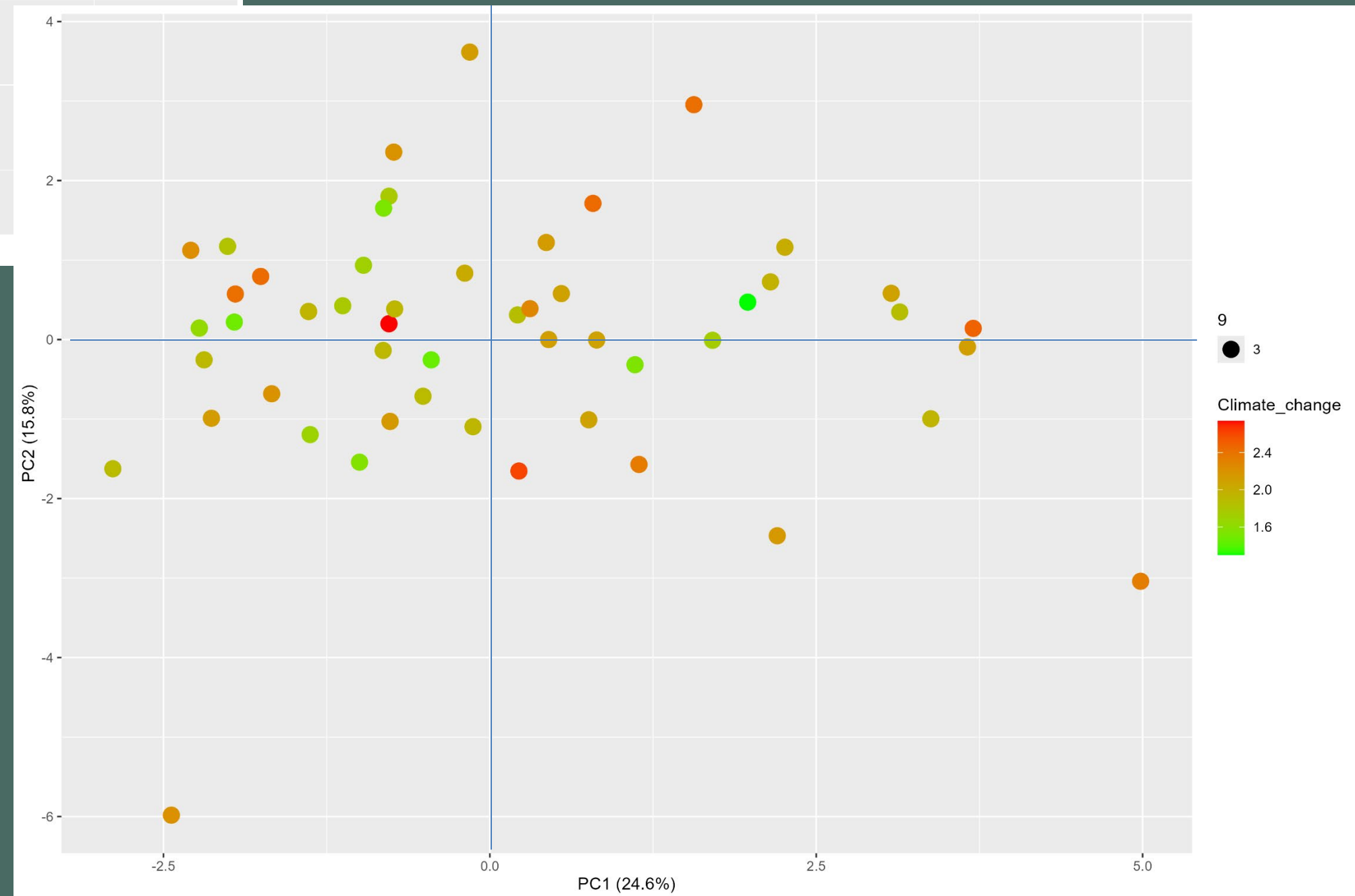
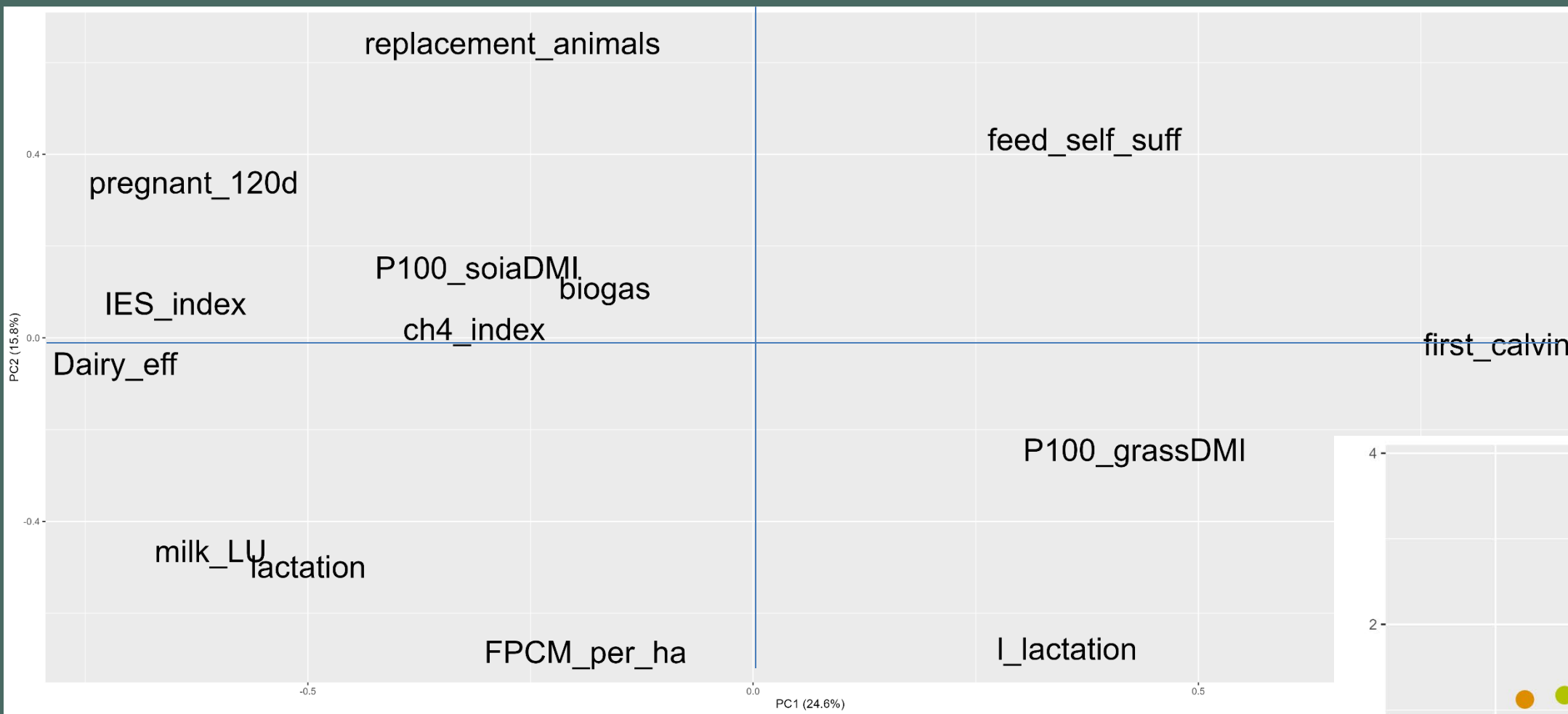
<sup>1</sup> FPCM, Fat and Protein Corrected Milk

<sup>2</sup> IES index, Health and Economic Index, Expresses as the expected economic difference (€) of individual animals (or daughters of bulls) from the reference genetic basis.

<sup>3</sup> CH4 index, Methane Emission Index

<sup>4</sup> LU, Livestock Unit

# RESULTS-PCA



# RESULTS-ESTIMATION OF CC



Table 2. Variables selected for the estimation of CC

Variable
Biogas
Percentage of soybean meal in the ration
IES (health and economic) genetic index
CH <sub>4</sub> (methane emission) genetic index
Age at first calving
Pregnant cows at 120 d
Milk sold per LU (livestock unit)

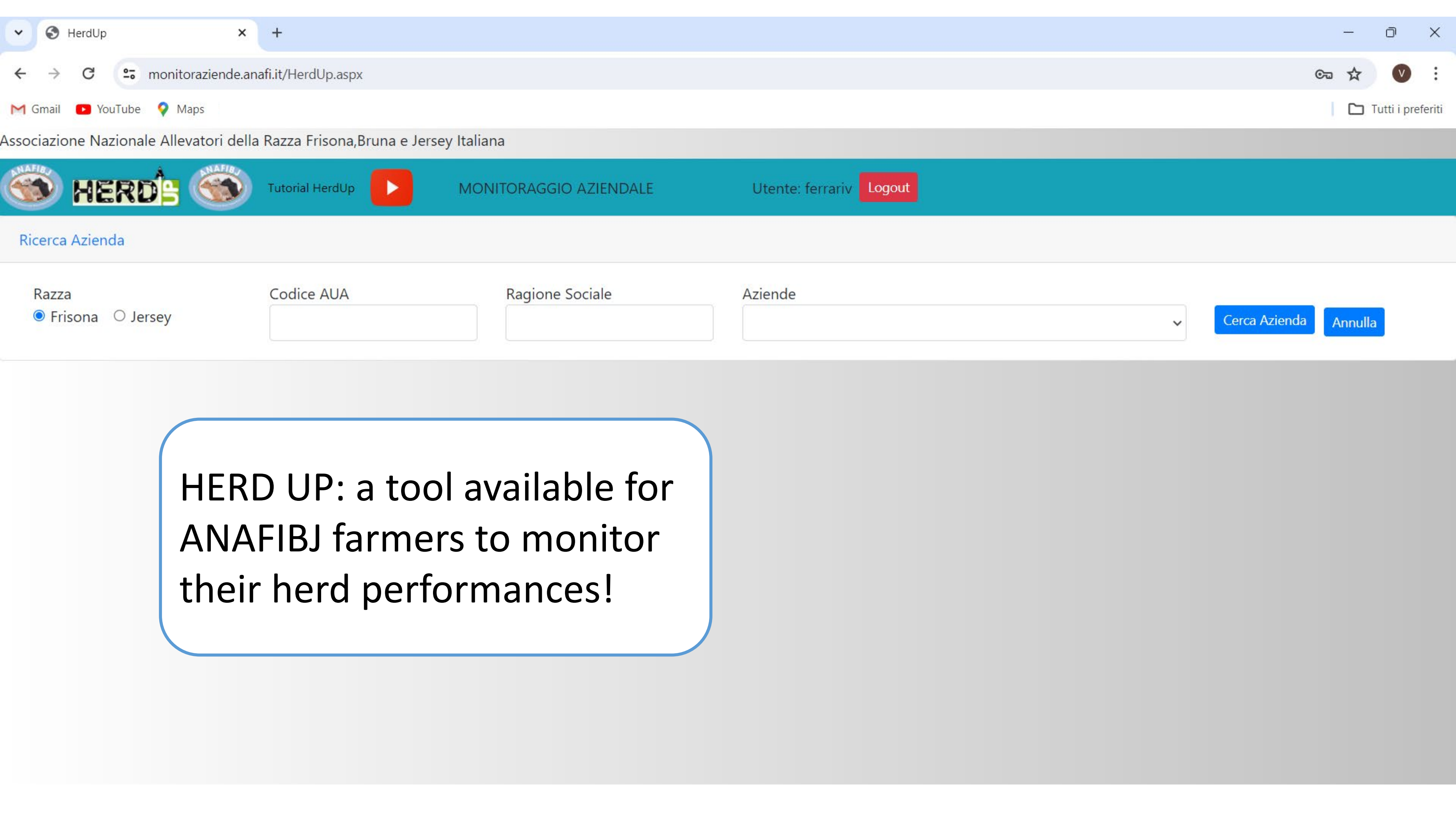
Adjusted R<sup>2</sup> of the equation was 0.63

Average correlation coefficient between CC<sub>es</sub> and CC was 0.77



# EXAMPLES OF APPLICATION

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Ricerca Azienda

Razza  
 Frisona  Jersey

Codice AUA

Ragione Sociale

Aziende

Cerca Azienda Annulla

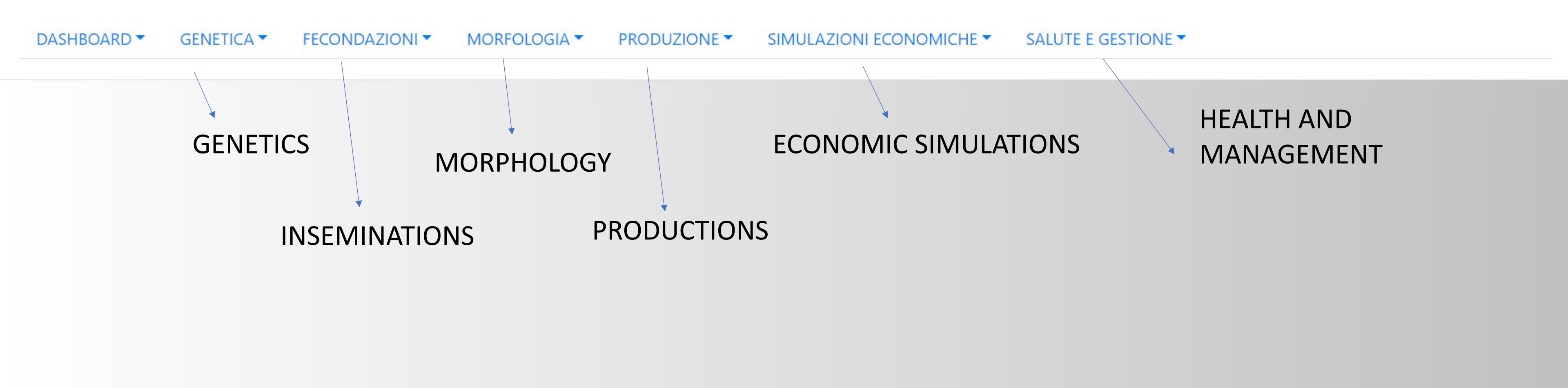
HERD UP: a tool available for ANAFIBJ farmers to monitor their herd performances!

Ricerca Azienda

Search filters for company selection:

- Razza:  Frisona  Jersey
- Codice AUA:
- Ragione Sociale:
- Aziende: 1

Stampe



Ricerca Azienda

Search filters for company selection:

- Razza:  Frisona  Jersey
- Codice AUA:
- Ragione Sociale:
- Aziende: 1

Stampe

- DASHBOARD ▾
- GENETICA ▾
- FECONDAZIONI ▾
- MORFOLOGIA ▾
- PRODUZIONE ▾
- SIMULAZIONI ECONOMICHE ▾
- SALUTE E GESTIONE ▾

- Key Performance Indicators
- Informazioni SCC
- Impatto Ambientale**
- Monitoraggio periodo di transizione

**Environmental impact**

# Herd environmental impact



Total UAA (Utilised agricultural area)	<input type="text" value="0"/>
Biogas	<input checked="" type="radio"/> Si <input type="radio"/> No
Organic Farm	<input type="radio"/> Si <input checked="" type="radio"/> No
Amount of hay in the ration (kg/d)	<input type="text" value="12,30"/>
Amount of soybean meal in the ration (kg/d)	<input type="text" value="1,73"/>
Total feed quantity (kg/d)	<input type="text" value="0,00"/>
Amount of protein concentrate in the ration (kg/d)	<input type="text" value="0,00"/>
Total dry matter intake per day	<input type="text" value="27,50"/>

Herd 1

Total UAA (Utilised agricultural area)	<input type="text" value="121"/>
Biogas	<input type="radio"/> Si <input checked="" type="radio"/> No
Organic Farm	<input type="radio"/> Si <input checked="" type="radio"/> No
Amount of hay in the ration (kg/d)	<input type="text" value="12,30"/>
Amount of soybean meal in the ration (kg/d)	<input type="text" value="2,70"/>
Total feed quantity (kg/d)	<input type="text" value="0,00"/>
Amount of protein concentrate in the ration (kg/d)	<input type="text" value="0,00"/>
Total dry matter intake per day	<input type="text" value="28,50"/>

## Herd 2

Parametri	Default	Simulazione
Reference year	2024	
Daily milk yield of current cows (kg/d)	39,70	<input type="text" value="40,00"/>
Estimated annual herd milk production (q/year)	47094,13	47450,00
Fat (%)	4,22	
Protein (%)	3,73	
Cows (lactation + dry) (n)	325	<input type="text"/>
Heifers > 12 mo (n)	83	<input type="text"/>
Heifers between 12 and 6 mo (n)	43	<input type="text"/>
Female calves < 6 mo (n)	51	<input type="text"/>
Age at first calving (mo)	22,43	<input type="text"/>
Average IES (Economic Sustainability Index) (Average of last 5 years)	559	
Average Predicted Methane Emission Index	101	
Herd milk yield sold/LU (livestock units)	10761,91	10843,24
Pregnant cows at 120 d (%)	62	<input type="text" value="70"/>
Herd environmental impact (kg CO2 eq./ kg milk)	1,23	<input type="text" value="1,16"/>

# In progress

To improve this predictive equation, has been set up a survey to be distributed to farmers of both countries and this would help:

- 1) understand the environmental impact management of farmers;
- 2) enlarge the number of farmers to be included in the analysis and
- 3) to test a wider area.

## Survey for farmers

**B** *I* U ↻ ✕

With the Department of Agricultural and Environmental Sciences at the University of Milan, an equation for calculating the environmental impact of businesses has been developed and is available in HerdUp, the ANAFIBJ management tool. To improve this predictive equation, we kindly request your participation in this brief survey. By proceeding, you confirm that you have reviewed the [ANAFIBJ Privacy Policy](#).

[https://docs.google.com/forms/d/e/1FAIpQLScDuvdP-V075PvInxTHNikZenG2K-JgvfA6LgDaNW9yP52oug/viewform?usp=sf\\_link](https://docs.google.com/forms/d/e/1FAIpQLScDuvdP-V075PvInxTHNikZenG2K-JgvfA6LgDaNW9yP52oug/viewform?usp=sf_link)